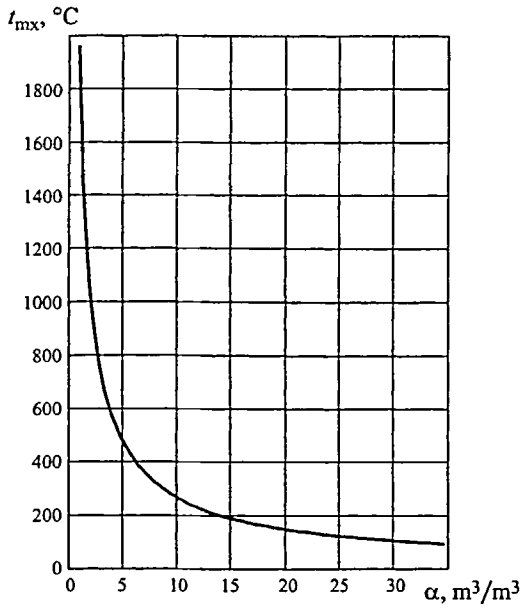

Fig. 2. Dependence of the temperature of gas-air mixture on the excess air coefficient.

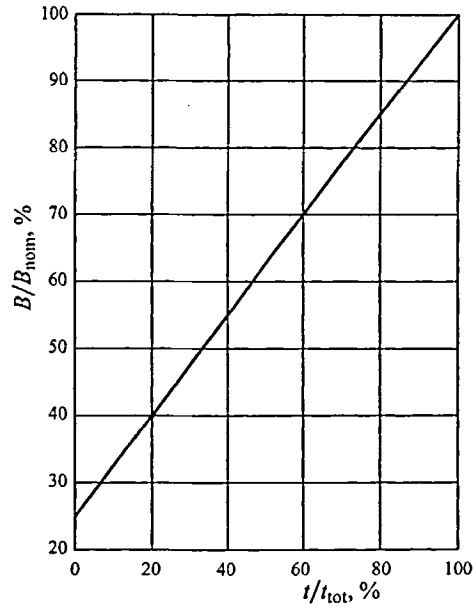

Fig. 3. Dynamics of fuel consumption in MHG during heat-up of the brickwork.

The combination of atmospheric air injected with a gas jet and the standard preburner pressure with subsequent forced dilution of the products is impeded by the substantial counterpressure arising in this case. The investigations proved that this solution is not promising. Therefore, the HG design developed by us is based on forced supply of air from a single fan in two flows: one used for combustion, and the other for dilution of the combustion products.

Note that a stationary HG installed on a specific furnace can be used only for that furnace, which would hamper access to the furnace and its maintenance in the course of operation. Such HG can be used only as an exception. A much more convenient solution is the mobile HG (MHG), which is a self-contained unit placed on a small rectangular platform. The latter can move on wheels over the production area like a battery-operated truck. On that platform the burner, the fuel supply unit, the unit for forced air dilution of combustion products, the blast fan with electric drive, and the HG automatic control system are located. The electric cable and flexible reinforced hose for the fuel supply are run from suspensions above the work area. In order to adjust the height of the branch pipe and supply the gas mixture to a specific furnace port, the MHG is shifted vertically on the platform and positioned at the required level by fixing it with bolts to the vertical posts.

The gas mixture flow is directed along the heated walls, hearth, and arch by the specific position of the MHG in the ports and the turning angle of the outlet branch pipe. The gas mixture flow rate at the outlet from the branch pipe ought to be quite high: from 80 to 140 m/sec.

In the beginning, heating of the furnace requires the minimum thermal capacity of the gas flow and a low temperature of the gas. Consequently, the fuel rate is low, and the excess-air coefficient is the highest (Fig. 2). As the brickwork becomes heated, B should increase and α should decrease.

The nominal thermal capacity of the MHG and the corresponding fuel rate are determined by the size of the furnace (the total mass of the refractories heated) and can be small ($B \leq 100-300$ m³/h), medium ($B = 300-100$ m³/h), or high ($B > 1000$ m³/h).

In using MHG of the required thermal capacity for heating the furnace, t_{mx} should be varied with time between 100 and 1400°C while maintaining automatically the required rate of the temperature increase. The temperature of the interior lining surface t_{int} up to 1200°C is controlled by a thermocouple placed at 20 mm from its surface, and the temperature above 1200°C is controlled by an optical pyrometer.

The fuel rate is increased uniformly and automatically over the heating period from its initial (minimum) value, equal to 20 – 25% of the nominal value (Fig. 3). The heating time is not indicated on the abscissa since it is different for different furnaces. As the fuel rate increases, the excess-air coefficient prescribed for its combustion and amounting to 1.2 – 1.4 is maintained by a proportion regulator through a butterfly valve on the air pipe leading to the burner. The air rate needed for dilution of the fuel combustion products is automatically regulated at each moment according to the temperature of the mixture required, so that the total excess-air coefficient will correspond to the value specified in Fig. 2. In order to maintain the heating schedule prescribed, the relationship between t_{mx} and t_{int} must be known. In the first approximation, it can be taken as $t_{mx} = t_{int} + (50-100)$°C, and after that it should be specified empirically for each furnace.

The design and development of the MHG were carried out for a nominal thermal capacity equivalent to 100 m^3/h or natural gas (combustion heat 36,090 kJ/m^3) for which the theoretical air rate is 9.58 m^3/m^3 and the respective combustion product output is 10.76 m^3/m^3. The composition of the combustion product (vol. %) is: 9.48 CO_2, 19.89 H_2O and 70.63 N_2.

Fig. 2 shows the design diagram of the main part of the MHG consisting of the burning and mixing units. The natural gas is fed through nozzle *1* with several lateral outlets and one main nozzle outlet along the burner axis. The section of the nozzle outlet is regulated by shifting cone *2* along the burner axis. The burner is located inside burner stone *3* positioned in the end wall of combustion chamber *4*. The air for combustion is fed by ring channel *5* around the central gas pipe, and the air to dilute the combustion products is supplied tangentially through branch pipe *6* into ring channel *7* and introduced in diffusor site *8* through openings *9* (first variant) or shutter rings *10* (second variant). The section of branch pipe *11* provides the required rate of the gas mixture supply. The active gas mixture flow propagates along the walls heated at the distance of 5 – 8 mm. The combustion chamber and the diffuser are made of heat-resistant steel, and the other metal parts are made of ordinary carbon steel.

The application of MHG makes it possible to reduce heating time and to provide for precise implementation of the schedule prescribed in steady heating of the entire furnace brickwork.

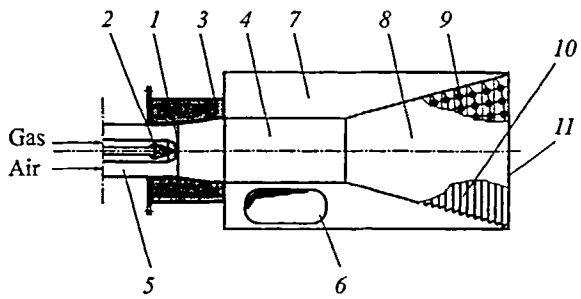

Fig. 4. Diagram of burner and mixing units in MHG.

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